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UNDERST

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As more challenging user requirements and technology considerations put pressure on municipalities and their local public safety organizations to enhance and improve their systems, communications evolve. Historically, public safety voice communications have been the predominant mission-critical communications “need” and will be for the foreseeable future. For the most part, these voice requirements have been met by communications operations in pre-defined (channelized) spectrum allocated by the Federal Communications Commission (FCC). On the other hand, the evolution to other services, such as data and video applications, is increasing the demand for higher capacity channels and driving the need for improved spectrum efficiency.

The FCC’s efforts to improve spectrum efficiency include 1) allocating more public safety frequency bands; 2) increasing available communications channels within limited spectrum bands; 3) improving spectrum management processes to enhance efficiency; and 4) promoting technology advancement, such as software-defined radio and cognitive radio. This article presents a cursory view of the FCC’s efforts to enhance public safety spectral efficiency by moving to narrower channel allocations.

NARROWBANDING

Public safety radio systems’ origins rest with traditional analog radio, and historical public safety radio frequency allocations are

effectively doubled or quadrupled the availability of usable channels in the same bandwidth.

This is known as *narrowbanding*, or *refarming*, and has been used to improve spectrum efficiency—especially in the crowded very high frequency (VHF) (150–170 MHz) and ultra high frequency (UHF) (421–512 MHz) land mobile radio (LMR) bands. In the 700- and 800-MHz bands, initial allocations started with more efficient band plans.

In December 2004, the FCC ruled that all private LMR users operating below 512 MHz must move to 12.5-kHz narrowband voice channels and highly efficient data channel operations by the end of 2012.² This deadline has now changed to Jan. 1, 2013. The rule implies mandatory narrowbanding implementation by not allowing any new licenses for devices and equipment with 25-kHz wide channels after Jan. 1, 2013. The rule change has considerable impact on public safety because most current public safety radio systems below 512 MHz still use 25-kHz voice channels. Thus, all municipal government and state and local public safety systems using 25-kHz radio systems must migrate to 12.5-kHz narrowband voice channels by Jan. 1, 2013.

This does not necessarily imply that any public safety agency is automatically guaranteed two 12.5-kHz channels from a previously licensed 25-kHz channel. To migrate to narrowband operations, agencies must apply for new narrowband licenses or modify exist-

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based on the use of analog technologies. Recent efforts to improve spectral efficiency have focused on migrating to digital techniques to effectively improve spectral efficiency without increasing overall bandwidth or reducing the quality of public safety communications. Coincident with the advances in digital technologies was a corresponding decrease in the required spectrum bandwidth to maintain the same quality of service for a given voice channel. *The result:* It was possible to increase the spectral efficiency of public safety spectrum allocations by reducing the single voice channel bandwidth from the traditional analog value of 25 kHz to a value of 12.5 kHz, and then further down to 6.25 kHz.¹ This approach

ing licenses, while justifying channel requirements, by the deadline.

Narrowbanding does not require moving to another frequency band. Agencies merely reduce the bandwidth of the channel(s) they are currently using. Most radios purchased in the past 10 years are already narrowband capable.

Careful planning for narrowbanding is a must. *Suggested steps:*

1. Verify that your agency has a current valid FCC Part 90 radio station license.
2. Conduct a full inventory of all radios operating on your system.
3. Contact a local professional two-way radio service vendor for assistance in identifying which radios in your inventory

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require reprogramming and/or replacement.

4. Start budgeting the migration.
5. Develop a wideband-to-narrowband system conversion plan.
6. Modify your license to show changes by submitting your FCC Form 601 application to a public safety frequency coordinator.

P25-DIGITAL COMMUNICATIONS

In response to the FCC narrowbanding initiative, the communications industry began developing standards for public safety LMR channels. Under a program called Project 25 (P25), APCO International and the Telecommunications Industry Association (TIA) have been instrumental in developing a standardized digital voice trunked system that accommodates and manages multiple signal channels for the digital LMR services for local, state and federal public safety communications.³ The standard is based on a 12.5-kHz channel bandwidth using a specific digital modulation technique. The development of the standard will eventually evolve to 6.25-kHz channel bandwidth.

700-/800-MHz ALLOCATIONS

Compared to spectrum below 512 MHz, the FCC's more recent 700- and 800-MHz public safety allocations started with more efficient channelization plans. *Example:* In a series of rulemakings mandated by Congress to begin in 1997, the FCC allocated 24 MHz of spectrum located in the 700-MHz band for public safety use (763–775 and 793–805 MHz).⁴ The FCC designated spectrum in the 700-MHz public safety band for use as follows: 12.5 MHz for general use, 2.6 MHz for interoperability, 2.4 MHz for state license, 0.3 MHz for low power, 0.2 MHz for secondary trunking and 6.0 MHz for reserve.

The FCC divided the 24 MHz of spectrum into 12 MHz of paired narrowband (6.25-kHz channel) and 10 MHz for paired broadband, with 2 MHz of paired guard band between the narrowband and broadband allocations. Since 1997, the FCC has adopted a series of operational and technical rules governing this spectrum.

The migration to narrowband channels below 512 MHz has not been smooth or problem free. Problems have arisen regarding the quality of digital services provided

over the reduced bandwidth channels. Most of the problems have been associated with the development of voice encoders and decoders. The reduced channel bandwidth puts an extreme burden on the signal processing capabilities of the radios, thereby making the quality of service difficult to meet in terms of the acceptable channel bit rates. With enhanced digital coding techniques, it's hoped that the quality of voice services requirements on the reduced channels can be met.

Narrowband channels will allow public safety communications users to take advantage of more efficient technology, as well as allow additional channel assignments by reducing channel width. In this regard, narrowbanding improves public safety's spectrum efficiency and, to some degree, will help achieve interoperability in the future. Achieving true interoperability will require resolving complex issues intertwining many practical elements, such as communications standards conformance, operational procedures, applications, security (encryption/decryption) methods, spectrum coordination and monitoring. *Example:* Even P25-compliant radio systems typically operate in only a single frequency band and set only one encryption type (either DES or AES) at a time. This means that without previous coordination among users, P25 devices can't talk to each other due to frequency incompatibility, encryption incompatibility or both.

700-MHz TRANSITION

The 700-MHz band comprises 108 MHz of spectrum from 698–806 MHz designated for commercial and public safety uses. Currently, this spectrum is occupied by television broadcasters in channels 52–69. Congress has directed that broadcasters transition to digital broadcast technology and vacate the spectrum to accommodate wireless commercial and public safety spectrum uses. The Digital Television and Public Safety Act of 2005 (DTV Act) set a firm deadline of Feb. 17, 2009, for the completion of the DTV transition. However, as we all know, this date was moved to June 12, 2009.

In July 2007, the FCC adopted the 700-MHz Second Report and Order that adopted a regulatory framework for the 700-MHz public safety band to facilitate the establishment of a nationwide

interoperable broadband communications network for the benefit of state and local public safety users. In implementing Congress' directive to reallocate the airwaves, the FCC is focused on serving the public interest. The new 700-MHz band service rules will help create a nationwide broadband network for public safety that will address many of the interoperability problems of today's systems.

To minimize interference between broadband and narrowband operations, the FCC adopted a 1-MHz guard band (768–769/798–799 MHz) between the public safety broadband and narrowband segments. Finally, the FCC established a single nationwide license—the Public Safety Broadband License—for the 700-MHz public safety broadband spectrum.

800-MHz REBANDING

To address a growing problem of harmful interference to 800-MHz public safety communications systems caused by high-density commercial wireless systems, the FCC adopted a comprehensive plan to reconfigure the band in July 2004. This plan is designed to protect the lives of first responders and other emergency personnel and fulfill the FCC's obligation to promote safety of life and property through the use of wire and radio communications. Implementation of 800-MHz band reconfiguration is a top priority of the FCC's Public Safety and Homeland Security Bureau.

A quick 800-MHz rebanding overview:

- This reconfiguration of the band is due to the interference received between dissimilar radio systems collocated in close frequency proximity.
- All associated costs will be covered by Sprint Nextel.
- Licensees will negotiate the process with Sprint Nextel.
- Rebanding is based on the FCC's Aug. 6, 2004 Report and Order.
- The FCC designated a Transition Administrator (TA) third party to oversee the rebanding process.
- Many (not all) licensees located in the 800-MHz band will be required to change the frequencies on which their radios operate.
 - All operations between 806/851 and 809/854 will move to 809/854 and 814/859

(spectrum cleared by Sprint Nextel).

- All NPSAC will move from 821/866 through 824/869 to 806/851 through 809/854 after that band is cleared.
- Agencies with systems operating between 814/859 and 816/861 will have the option to move lower in the band.
- The country is segregated into four waves by the TA's Prioritization Plan.
- The reconfiguration formally started on June 28, 2005, with the first of the four waves. Subsequent Waves started three months after.
- The process was slated for completion 36 months from its start. However, rebanding is ongoing.

The move to narrower channels is an important and ongoing effort. In conjunction with the 700-MHz narrowband public safety allocations, the rebanding currently underway in the 800-MHz band should provide public safety users with adequate spectrum to provide for essential mission-critical voice communications. **||PSC||**

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END NOTES:

1. Private LMR systems (FCC Part 90), including municipal government, state and local public safety systems, use blocks of radio spectrum called channels. A channel is configured by frequency, bandwidth and deviation. See www.fcc.gov/pshs/techtopics/techtopics16.html#fn1#fn1.
2. See FCC Order 05-9, WT Docket No. 96-86, Jan. 7, 2005, at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-9A1.pdf and FCC Order 04-292, WT Docket No. 99-87 and RM-9932, Dec. 23, 2004, at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-292A1.pdf. See www.fcc.gov/pshs/techtopics/techtopics16.html#fn2#fn2.
3. "Recognizing the need for common standards for first responders and homeland security/emergency response professionals, representatives from the Association of Public Safety Communications Officials International (APCO), the National Association of State Telecommunications Directors (NASTD), selected federal agencies and the National Communications System (NCS) established Project 25, a steering committee for selecting voluntary com-

mon system standards for digital public safety radio communications. TIA TR-8 facilitates such work through its role as an ANSI-accredited Standards Development Organization (SDO) and has developed in TR-8 the 102 series of technical documents." See the TIA Project 25 Web site at http://www.tiaonline.org/standards/technology/project_25/index.cfm?standards/project_25/. Further details are available at www.apcointl.org/frequency/project25/information.html. Also see www.fcc.gov/pshs/techtopics/techtopics16.html#fn3#fn3.

4. See http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-132A1.pdf or www.fcc.gov/pshs/techtopics/techtopics16.html#fn4#fn4.

RESOURCES

- 800 MHz Transition Administrator: www.800ta.org
- APCO International: www.apcointl.org
- Federal Communications Commission: www.fcc.gov
- National Institute of Justice: www.ojp.usdoj.gov
- Telecommunications Industry Association: www.tiaonline.org

1. **What has historically been the predominant mission-critical public safety communications need?**
 - a. Voice communications
 - b. Data transfer
 - c. Spectrum allocation
 - d. Video applications

2. **Which of the following is not one of the FCC's efforts to improve spectrum efficiency?**
 - a. Allocating more public safety frequency bands.
 - b. Decreasing available communications channels within limited spectrum bands.
 - c. Improving spectrum management to enhance efficiency.
 - d. Promoting technology advancement, such as software-defined radio.

3. **The term *refarming* refers to:**
 - a. Changing public safety communications to digital format.
 - b. Restricting radio frequencies to mixed base only.
 - c. Using cell signals for radio communications.
 - d. Narrowbanding channels to improve spectrum efficiency.

4. **Spectral efficiency can be enhanced by:**
 - a. Migrating from digital to analog.
 - b. Migrating from analog to digital.
 - c. Migrating from mixed base to mobile based.
 - d. Migrating from mobile based to mixed based.

5. **When a single voice channel bandwidth having an analog value of 25 kHz is reduced:**
 - a. The availability of usable channels is reduced.
 - b. The availability of usable channels is increased.
 - c. The bandwidth must be increased.
 - d. The bandwidth must be decreased.

6. **Careful planning for the narrowbanding process is important because:**
 - a. It is a free service provided by the FCC if you have a plan in place before January 2013.
 - b. No new radios are narrowband capable.
 - c. You must move to another frequency.
 - d. There are many steps involved with the narrowbanding process.

7. **At this time, what is date for the completion of the DTV transition?**
 - a. Feb. 17, 2009
 - b. July 12, 2009
 - c. June 12, 2009
 - d. Feb. 17, 2010

8. **What is the purpose of 800-MHz rebanding?**
 - a. To protect the lives of first responders.
 - b. To give commercial wireless systems more freedom.
 - c. To make money off of cell phone companies for use in public safety.
 - d. It is required every 20 years.

9. **All P25-compliant radios are compatible with each other.**
 - a. True
 - b. False

10. **Who is paying for 800-MHz rebanding?**
 - a. The FCC
 - b. The NPSPAC
 - c. AllTell
 - d. Sprint Nextel

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